Asthma and pregnancy: repercussions for neonates*

Asma e gravidez: repercussões no recém-nascido

Maria Luiza Doria Almeida, Priscila Andrade Santana, Alzira Maria d'Ávila Nery Guimarães, Ricardo Queiroz Gurgel, Elcio Oliveira Vianna

Abstract

Objective: To describe socioeconomic and behavioral aspects of pregnant women with asthma and to analyze the effects of maternal asthma on certain perinatal parameters in a birth cohort. **Methods:** An observational cross-sectional analytical study using data regarding the mothers of a birth cohort at maternity hospitals in the greater metropolitan area of Aracaju, Brazil, between the 8th of March and the 15th of July of 2005. In the pregnant women, asthma was self-reported, based on previous medical diagnosis. Epidemiological, obstetric and perinatal variables were studied. **Results:** Of the 4,757 mothers included in the study, 299 (6.3%) had asthma. The mothers with asthma had lower family incomes and more frequently made use of the public health care system (for prenatal care and delivery) than did those without asthma. Although only 9.4% of the mothers with asthma smoked and only 27.6% consumed alcoholic beverages, these proportions were higher than were those observed for the control group. Asthma was not found to be associated with obstetric problems or with problems involving the neonates. Nor did we find asthma to be associated with cesarean delivery, prematurity or small-for-gestational-age neonates. **Conclusions:** Low socioeconomic level seems to be a risk factor for asthma.

Keywords: Asthma; Pregnancy; Socioeconomic factors; Infant, newborn.

Resumo

Objetivo: Descrever, numa coorte de nascimentos, aspectos socioeconômicos e comportamentais de gestantes com asma e analisar as repercussões desta sobre alguns parâmetros perinatais. **Métodos:** Estudo observacional, transversal e analítico a partir de informações de parturientes da coorte de nascimentos ocorridos no período entre 8 de março e 15 de julho de 2005 nas maternidades da Grande Aracaju (SE). A identificação de asma nas gestantes foi obtida segundo informação destas a partir do diagnóstico emitido anteriormente por um médico. Foram analisadas variáveis epidemiológicas, obstétricas e perinatais. **Resultados:** Das 4.757 parturientes incluídas no estudo, 299 (6,3%) eram asmáticas. As mães asmáticas tinham menor renda familiar e mais frequentemente procuraram assistência no pré-natal e no parto em serviços públicos que as mães sem asma. Embora somente 9,4% das gestantes asmáticas fumaram, e 27,6% ingeriram bebidas alcoólicas, as proporções em relação ao grupo controle foram significativamente maiores. Não se detectou associação entre asma e problemas obstétricos ou do recém-nascido. Não foi encontrada associação entre asma e parto cesariano, prematuridade ou recém-nascido sendo pequeno para a idade gestacional. **Conclusões:** O nível socioeconômico inferior parece ser um fator de risco para a asma.

Descritores: Asma; Gravidez; Fatores socioeconômicos; Recém-nascido.

Introduction

Asthma is the most common chronic respiratory disease among pregnant women. In recent years, asthma has garnered an increasing amount of attention because of the morbidity and mortality with which it is associated, as well as because of its increasing prevalence.[1,2] Consequently, specialists have made countless efforts to define appropriate strategies for the management of asthma.

Various aspects can influence the development and expression of asthma or can be influenced by it, adversely or not.[2] Such aspects include markers of maternal and fetal health, ranging from maternal socioeconomic status to obstetric

* Study carried out at the Federal University of Sergipe, Aracaju, Brazil.

Correspondence to: Maria Luiza Doria Almeida. Rua Claudio Batista, s/n, Sanatório, CEP 49060-100, Aracaju, SE, Brasil.
Tel 55 79 2105-1744. E-mail: luiza_doria@hotmail.com

Financial Support: This study received financial support from the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq, National Council for Scientific and Technological Development).
Submitted: 18 August 2009. Accepted, after review: 25 February 2010.

data, intrauterine growth parameters, neonatal vitality and neonatal prognosis.[3]

In Brazil, there is a scarcity of data on asthma in pregnant women, whereas such data are extensive and diverse in the international literature. There is no consensus regarding the classification of asthma as a risk factor for conditions such as cesarean delivery, preterm delivery, low Apgar score, small-for-gestational-age (SGA) birth and intrauterine growth retardation (IUGR).[4]

The objectives of the present study were to determine the proportion of pregnant women with asthma within a given population; to identify the characteristics of those women, of the delivery and of the neonates; and to compare pregnant women with and without asthma in terms of those characteristics.

Studies such as this can further the understanding of the local and regional conditions, as well as allowing the identification of modifiable risk factors, which in turn allows the adoption of asthma control measures and, consequently, the prevention of health problems in pregnant women and neonates.

Methods

This was an observational cross-sectional analytical study using secondary data from a birth cohort study designated "*Estudo Epidemiológico-social da Saúde Perinatal de Partos Hospitalares da Grande Aracaju*" ("Social and Epidemiological Study of Perinatal Health for Hospital Deliveries in the Greater Metropolitan Area of Aracaju"), conducted between March 8 and July 15 of 2005. The greater metropolitan area of Aracaju, the capital of the state of Sergipe, Brazil, comprises the cities of Barra dos Coqueiros, Nossa Senhora do Socorro and São Cristóvão.

Data were collected from women whose pregnancies resulted in singleton live births at maternity hospitals in the greater metropolitan area of Aracaju during the study period. The perinatal data were compiled into a database. The study design was approved by the Research Ethics Committee of the Federal University of Sergipe, Brazil, and all participating subjects gave written informed consent.

A questionnaire, which included questions related to asthma, was administered to 4,757 women. The pregnant women who reported having physician-diagnosed asthma before or during gestation were collective designated the study group, the remaining group of patients being designated the comparison group. The diagnostic method and the specific treatment of asthma were not investigated. Variables that might be directly or indirectly related to asthma were selected for analysis.

The variables "prenatal care" and "medical treatment during hospitalization" were studied under two categories: public (Brazilian Unified Health Care System) and private (including the fully private health insurance plans, private-public partnership plans and plans funded by social welfare programs at the state level).

Deliveries occurring before the fetus had reached the gestational age (GA) of 37 weeks were classified as preterm births, according to the classification of the World Health Organization.[5] The Apgar score cut-off value was 8, since adverse effects are associated with Apgar scores < 8.[6]

We classified neonates using the system devised by Williams et al.,[7] which focuses on the appropriateness of birth weight for GA. Birth weight is classified as appropriate for GA (AGA, from the 10th to the 90th percentile), SGA (below the 10th percentile) or large for GA (LGA, above the 90th percentile).

The data were processed with the Epi Info program, version 3.4.2. To compare the qualitative and categorical variables, we used Fisher's exact test and the chi-square test. Values of $p < 0.05$ were considered statistically significant.

Multivariate logistic regression was used for the following variables: skin color; consumption of alcoholic beverages during pregnancy; smoking during pregnancy; and SGA birth. In order to analyze the appropriateness of birth weight for GA, we first studied the effect that each independent variable had on the birth of an SGA neonate, separately, comparing the proportions by means of the chi-square test. Based on the results, we selected the variables to include in the multiple logistic regression model, which was adjusted for the remaining independent variables, thereby determining the correlation between asthma and the birth of an SGA neonate.

Results

Of the 4,757 women interviewed in the cohort, 299 reported having been diagnosed

with asthma, before or during the pregnancy, corresponding to a prevalence of 6.3%. Variables for which the frequency was less than 5% were not included in the analysis.

As can be seen in Table 1, there were statistically significant differences between the two groups regarding the following socioeconomic variables: maternal level of education; family income; prenatal care provided by the private sector; and delivery carried out at a private hospital. The proportion of White females was significantly higher in the study group than in the comparison group (p = 0.022). According to the multiple regression analysis, White females were 1.43 times more likely to have asthma than were non-White females.

Table 2 shows that the proportion of women who reported smoking during pregnancy was a significantly higher in the study group than in the comparison group (p = 0.0047), as later confirmed in the multivariate analysis. A similar phenomenon was observed regarding the consumption of alcohol during pregnancy: 27.6% and 20.3% of the mothers of the study group and comparison group, respectively, reported having consumed alcohol during pregnancy (p = 0.0021).

Most of the pregnant women in the study group (98.7%) reported having received prenatal care, without a statistically significant difference in relation to the comparison group (Table 3).

The univariate analysis showed that asthma was not a risk factor for cesarean delivery.

Most of the mothers in the study group gave birth to an infant with a GA ≥ 37 weeks. There were no significant differences between the two groups regarding the proportion of preterm deliveries (p = 0.816).

Regarding the appropriateness of birth weight for GA, the univariate analysis showed that there were no significant differences between the two groups in terms of the risk of delivering an

Table 1 - Socioeconomic variables in pregnant women with and without asthma.

Variable	With asthma		Without asthma		Total	p
	n	%	n	%	n	
Skin color						
Non-White	240	81.1	3766	85.8	4006	0.024
White	56	18.9	621	14.2	677	
Residence						
Urban	282	94.3	4193	94.3	4475	0.5456
Rural	17	5.7	254	5.7	271	
Maternal level of education						
≤ 4 years of schooling	70	23.4	839	18.9	909	0.054
≥ 5 years of schooling	227	75.9	3576	80.4	3803	
Smoking during pregnancy						
Yes	28	9.4	223	5.0	251	0.0047
No	271	90.6	4222	94.9	4493	
Alcohol consumption during pregnancy						
Yes	82	27.6	895	20.3	977	0.0021
No	215	72.4	3520	79.7	3735	
Family income						
< 1 × the minimum wage	39	13.0	528	11.9	567	0.0025
1 to < 3 × the minimum wage	230	76.9	3286	73.9	3516	
≥ 3 × the minimum wage	30	10.0	633	14.2	663	
Nature of prenatal care						
Public[a]	225	86.4	3351	76.7	4370	< 0.001
Private[b]	40	13.6	1019	23.3	295	
Nature of maternity ward care						
Public[a]	280	94.0	3761	84.7	4438	< 0.001
Private[b]	18	6.0	677	15.3	298	

[a]Via the Brazilian Unified Health Care System. [b]Via fully private health insurance plans, private-public partnership plans or plans funded by social welfare programs at the state level.

Table 2 - Univariate analysis, adjusted through multiple logistic regression, of the variables skin color, smoking during pregnancy and alcohol consumption during pregnancy, in relation to the presence of asthma.

Variable	OR	95% CI	p
Skin color			
Non-White (reference)			
White	1.43	1.05-1.94	0.022
Smoking during pregnancy			
Yes	1.59	1.03-2.45	0.0035
No (reference)			
Alcohol consumption during pregnancy			
Yes	1.35	1.03-1.77	0.0032
No (reference)			

SGA neonate. The multiple regression analysis confirmed that asthma was not a risk factor for giving birth to an SGA neonate (Tables 4 and 5).

Finally, there was no significant association between maternal asthma and the birth of a neonate with a low Apgar score.

Discussion

The relationship between asthma and pregnancy is one of the most complex relationships in human physiology. This relationship has yet to be fully understood, and there are numerous discrepancies among studies on the subject.[4] The discrepancies are related to differences in study design, the degree of control for confounding factors, the definition of asthma and its classification (by etiology and severity), as well as to the multifactorial nature of asthma, to the deleterious effects that asthma has on the mother/fetus during pregnancy and to the effects of asthma medication.[8] However, there is widespread agreement in the scientific community that asthma is a risk factor during pregnancy, and that, conversely, pregnancy influences the symptoms of asthma.[3,4] In the present study, the prevalence of asthma in pregnant women was 6.3%. This finding is in accordance with data in the literature, the reported prevalence rates of asthma among pregnant women ranging from 3.2% to 8.4%.[9] We found that White mothers were predisposed to asthma, lending credence to the hygiene hypothesis. According to that hypothesis, exposure to sensitizing agents during intrauterine life or early childhood protects against the development of allergic asthma, and socioeconomically advantaged individuals are therefore more likely to develop asthma.[10]

In the present study, asthma was more prevalent among pregnant women in the lower socioeconomic classes, as determined by family income, by the nature of the prenatal care provider (public or private) and by the maternal level of education. This finding is in accordance with reported changes in the pattern of the populations affected; there has been an

Table 3 - Obstetric variables in pregnant women with and without asthma.

Variable	With asthma		Without asthma		Total	p
	n	%	n	%	n	
Prenatal care						0.771
No	4	1.3	69	1.6	73	
Yes	295	98.7	4376	98.4	4671	
Type of delivery						0.7214
Vaginal	212	70.9	3030	68.1	3242	
Cesarean	87	29.1	1411	31.7	1498	
Preterm delivery						0.816
Yes	24	8.14	327	7.76	351	
No	271	91.86	3887	92.24	4158	
Birth of an SGA neonate						0.610
Yes	16	5.4	270	6.1	286	
No	283	94.6	4174	93.9	4457	
Apgar score						0.699
≥ 8	262	87.63	3927	88.37	4189	
< 8	37	12.37	517	11.63	554	

SGA: small-for-gestational-age.

Table 4 - Appropriateness of birth weight for gestational age, correlated with independent variables, in Aracaju, Brazil, in 2005.

Variable	Birth weight				Total	p
	SGA		AGA or LGA			
	n	%	n	%	n	
Maternal asthma						0.610
Yes	16	5.4	283	94.6	299	
No	270	6.1	4174	93.9	4444	
Maternal age, years						< 0.001
< 18	42	9.2	415	90.8	457	
18-19	43	8.2	480	91.8	523	
20-34	168	5.0	3166	95.0	3334	
≥ 35	33	7.6	399	92.4	432	
Maternal level of education						0.504
≤ 4 years of schooling	61	6.5	878	93.5	939	
≥ 5 years of schooling	225	5.9	3578	94.1	3803	
Family income						0.015
< 1 × the minimum wage	49	8.6	518	91.4	567	
1 to < 3 × the minimum wage	158	5.9	2544	94.1	2702	
≥ 3 × the minimum wage	77	5.3	1377	94.7	1454	
Prenatal care						0.003
None	8	10.7	67	89.3	75	
Inappropriate	108	7.4	1357	92.6	1465	
Appropriate	155	5.2	2857	94.8	3012	
Nature of maternity ward care						0.010
Public[a]	258	6.4	3783	93.6	4041	
Private[b]	27	3.9	668	96.1	695	
Alcohol consumption during pregnancy						0.388
Yes	65	6.6	918	93.4	983	
No	221	5.9	3540	94.1	3761	
Smoking during pregnancy						< 0.001
Yes	28	11.2	223	84.8	251	
No	258	5.7	4235	94.3	4493	
Maternal hypertension						0.125
Yes	51	7.3	647	92.7	698	
No	235	5.8	3810	94.2	4045	
Preterm delivery						0.815
Yes	22	6.3	329	93.7	351	
No	248	6.0	3913	94.0	4161	

SGA: small for gestational age; AGA: appropriate for gestational age; and LGA: large for gestational age. [a]Via the Brazilian Unified Health Care System. [b]Via fully private health insurance plans, private-public partnership plans or plans funded by social welfare programs at the state level.

increase in the number of asthma patients in socioeconomically disadvantaged populations, such as individuals of African or Hispanic descent living in developed countries, as well as certain European subpopulations and the majority of individuals living in developing countries.[1,11] One retrospective study showed the prevalence of asthma to be higher among individuals of lower socioeconomic status and with a lower level of education, regardless of their atopic status, and this higher prevalence was attributed to exposure to allergens in the disadvantaged community where the subjects lived.[12] In Brazil, there are data showing increased occupational exposure to allergens and higher asthma prevalence in disadvantaged populations.[13,14] Another study conducted in Brazil did not identify low income as being a protective factor for asthma.[15]

Table 5 - Univariate analysis, adjusted through multiple logistic regression, of independent variables, in relation to the birth of a small-for-gestational-age neonate.

Variable	OR	95% CI	p
Maternal asthma			
Yes	0.85	0.50-1.44	0.543
No (reference)			
Maternal age, years			
< 18	1.70	1.17-2.48	0.006
18-19	1.65	1.15-2.37	0.006
20-34 (reference)			
> 35	1.45	0.96-2.18	0.076
Family income			
< 1 × the minimum wage	1.10	0.73-1.67	0.635
1 to < 3 × the minimum wage	0.81	0.59-1.10	0.173
≥ 3 × the minimum wage (reference)			
Prenatal care			
None	1.58	0.73-3.44	0.246
Inappropriate	1.26	0.97-1.65	0.088
Appropriate (reference)			
Nature of maternity ward care			
Public[a] (reference)			
Private[b]	0.60	0.37-0.97	0.036
Smoking during pregnancy			
Yes	1.76	1.13-2.73	0.013
No (reference)			
Maternal hypertension			
Yes	1.36	0.98-1.90	0.064
No (reference)			

[a]Via the Brazilian Unified Health Care System. [b]Via fully private health insurance plans, private-public partnership plans or plans funded by social welfare programs at the state level.

In the present study, the proportion of women who consumed alcohol or smoked during pregnancy was greater in the study group than in the comparison group. This finding is doubly worrisome, since alcohol consumption and smoking have both been correlated with asthma exacerbations and with greater asthma severity,[16-18] as well as with adverse effects on the fetus and child, including IUGR, prematurity and childhood asthma.[19,20]

This finding might be related to low socioeconomic status (a characteristic of the sample investigated in the present study). According to data from the World Health Organization, the fact that lower socioeconomic class is associated with smoking and alcohol consumption is well established.[21]

Regarding environmental exposure as a risk factor for asthma, the univariate analysis showed that there was no statistically significant difference between the pregnant women with asthma and those without asthma in terms of the type of residence (urban or rural). Any such difference would be difficult to interpret, since there is no consensus in the literature regarding urban pollution as a risk factor for the development of asthma.[2]

There are scientific data, often discrepant, showing that asthma is or is not a risk factor for conditions such as cesarean delivery, preterm delivery, SGA birth, IUGR and low Apgar score.[3,4,22,23] In the present study, we found no association between maternal asthma and cesarean delivery. Most of the studies on the topic have shown that cesarean delivery is associated with asthma of greater severity.[3,24] However, in the present study, it was not possible to classify asthma severity. We performed our analysis without confirmation of physician-diagnosed asthma.

A prospective multicenter study carried out in the USA demonstrated that the proportion of cesarean deliveries was higher among pregnant women with moderate or severe asthma than among those without asthma, and that the rate of cesarean delivery among pregnant women with mild asthma was similar to that observed among those without asthma.[24] A retrospective study using data from the USA showed that the proportion of women undergoing cesarean section was higher among those with asthma, regardless of the severity of the asthma.[3]

In the present study, we found no evidence that asthma induces preterm delivery. There is no consensus in the literature regarding the influence of asthma on GA.[4,22] Studies on the topic should give special attention to the analysis of confounding factors, such as the presence of other diseases in the mother.[3]

In a study carried out in the USA, the proportion of preterm neonates born to mothers with asthma was greater than was that of preterm neonates born to mothers without asthma.[25] One cohort analysis, in which the authors controlled for confounding factors, also showed higher rates of preterm delivery among mothers with asthma.[26] Conversely, another group of authors,

in a retrospective study using multivariate analysis, found no association between preterm birth and maternal asthma.[3] Another neonatal complication that can be induced by maternal asthma is SGA birth. Neonatal complications are especially common among women with asthma that is more severe.[27,28]

In a retrospective study using data from Canada, the proportion of subsequent growth disturbances was found to be higher among SGA neonates born to mothers with asthma,[28] a finding that is analogous to that of the previously cited retrospective study using data from the USA.[3] A prospective, multicenter study involving 2,620 pregnant women reported findings similar to those of the present study.[24] In that study, multiple regression analysis showed that there was no association between the presence of asthma and the birth of an SGA neonate.

We observed that, regarding SGA neonates, the diagnosis of maternal asthma, per se, did not imply a risk of adverse effects for the neonate. This finding led us to infer that the clinical presentation of asthma among the pregnant women evaluated in the present study was not severe, since asthma that is more severe (resulting in hypoxemia) would be likely to induce a certain degree of IUGR.[27]

Because we used secondary data that did not include the classification of the severity of asthma, we were unable to perform a more in-depth analysis. Therefore, we recommend that investigations of this topic be expanded to involve the classification of the severity of asthma in pregnant women and a more complete characterization of their prenatal care, as well as the evaluation of asthma treatment management, together with longer follow-up periods in order to identify any additional long-term effects that maternal asthma has on the offspring. Another limitation of the present study is that the diagnosis of maternal asthma was based on self reports from the mothers and not on medical documentation. This might represent a bias related to mothers in whom asthma had gone undiagnosed, whether due to a lack of knowledge on the part of the mother or to an oversight on the part of the attending physician.

From a public health standpoint, it should be noted that a self-reported diagnosis of asthma in pregnant women or new mothers typically has no obstetric or neonatal implications. Although cases of asthma that are more severe likely merit special attention, determining the effects of the degree of asthma severity was not the objective of the present study. Here, we have presented pertinent, novel data related to the (low) frequency of smoking during pregnancy and the prevalence of asthma in the population studied, as well as socioeconomic data related to asthma and pregnancy.

Acknowledgments

We would like to thank Professor Luiz de Souza for the crucial guidance and valuable assistance in the statistical analysis of the data.

References

1. Braman SS. The global burden of asthma. Chest. 2006;130(1 Suppl):4S-12S.
2. Global Initiative for Asthma (GINA) [homepage on the Internet]. Bethesda: National Heart, Lung and Blood Institute. National Institutes of Health, US Department of Health and Human Services; c2000 [updated Jul 2007; cited 2008 Jan 26]. Available from: http://www.ginasthma.org.
3. Enriquez R, Griffin MR, Carroll KN, Wu P, Cooper WO, Gebretsadik T, et al. Effect of maternal asthma and asthma control on pregnancy and perinatal outcomes. J Allergy Clin Immunol. 2007;120(3):625-30.
4. Murphy VE, Gibson PG, Smith R, Clifton VL. Asthma during pregnancy: mechanisms and treatment implications. Eur Respir J. 2005;25(4):731-50.
5. Appropriate technology for birth. Lancet. 1985;2(8452):436-7.
6. Paulucci RS, Nascimento LF. Mortalidade neonatal em Taubaté: um estudo caso-controle. Rev Paul Ped. 2007;25(4):358-63.
7. Williams RL, Creasy RK, Cunningham GC, Hawes WE, Norris FD, Tashiro M. Fetal growth and perinatal viability in California. Obstet Gynecol. 1982;59(5):624-32.
8. Rey E, Boulet LP. Asthma in pregnancy. BMJ. 2007;334(7593):582-5.
9. Kwon HL, Belanger K, Bracken MB. Asthma prevalence among pregnant and childbearing-aged women in the United States: estimates from national health surveys. Ann Epidemiol. 2003;13(5):317-24.
10. Strachan DP. Hay fever, hygiene, and household size. BMJ. 1989;299(6710):1259-60.
11. Gonzales M, Malcoe LH, Myers OB, Espinoza J. Risk factors for asthma and cough among Hispanic children in the southwestern United States of America, 2003-2004. Rev Panam Salud Publica. 2007;21(5):274-81.
12. Basagaña X, Sunyer J, Kogevinas M, Zock JP, Duran-Tauleria E, Jarvis D, et al. Socioeconomic status and asthma prevalence in young adults: the European Community Respiratory Health Survey. Am J Epidemiol. 2004;160(2):178-88.
13. Caldeira RD, Bettiol H, Barbieri MA, Terra-Filho J, Garcia CA, Vianna EO. Prevalence and risk factors for work

related asthma in young adults. Occup Environ Med. 2006;63(10):694-9.
14. Felizola ML, Viegas CA, Almeida M, Ferreira F, Santos MC. Prevalence of bronchial asthma and related symptoms in schoolchildren in the Federal District of Brazil: correlations with socioeconomic levels. J Bras Pneumol. 2005;31(6):486-91.
15. Britto MC, Freire EF, Bezerra PG, Brito Rde C, Rego Jda C. Low income as a protective factor against asthma in children and adolescents treated via the Brazilian Unified Health System. J Bras Pneumol. 2008;34(5):251-5.
16. Boulet LP, Lemière C, Archambault F, Carrier G, Descary MC, Deschesnes F. Smoking and asthma: clinical and radiologic features, lung function, and airway inflammation. Chest. 2006;129(3):661-8.
17. Pietinalho A, Pelkonen A, Rytilä P. Linkage between smoking and asthma. Allergy. 2009;64(12):1722-7.
18. Vally H, Thompson PJ. Alcoholic drinks and asthma. Clin Exp Allergy. 2002;32(2):186-91.
19. Freire TM, Machado JC, Melo EV, Melo DG. Efeitos do consumo de bebida alcoólica sobre o feto. Rev Bras Ginecol Obstet. 2005;27(7):376-81.
20. Hammoud AO, Bujold E, Sorokin Y, Schild C, Krapp M, Baumann P. Smoking in pregnancy revisited: findings from a large population-based study. Am J Obstet Gynecol. 2005;192(6):1856-62; discussion 1862-3.
21. Blakely T, Hales S, Kieft C, Wilson N, Woodward A. The global distribution of risk factors by poverty level. Bull World Health Organ. 2005;83(2):118-26.
22. Tata LJ, Lewis SA, McKeever TM, Smith CJ, Doyle P, Smeeth L, et al. A comprehensive analysis of adverse obstetric and pediatric complications in women with asthma. Am J Respir Crit Care Med. 2007;175(10):991-7.
23. Sheiner E, Mazor M, Levy A, Wiznitzer A, Bashiri A. Pregnancy outcome of asthmatic patients: a population-based study. J Matern Fetal Neonatal Med. 2005;18(4):237-40.
24. Dombrowski MP, Schatz M, Wise R, Momirova V, Landon M, Mabie W, et al. Asthma during pregnancy. Obstet Gynecol. 2004;103(1):5-12.
25. Beckmann CA. The effects of asthma on pregnancy and perinatal outcomes. J Asthma. 2003;40(2):171-80.
26. Breton MC, Beauchesne MF, Lemière C, Rey E, Forget A, Blais L. Risk of perinatal mortality associated with asthma during pregnancy. Thorax. 2009;64(2):101-6. Erratum in: Thorax. 2009;64(6):550.
27. Bracken MB, Triche EW, Belanger K, Saftlas A, Beckett WS, Leaderer BP. Asthma symptoms, severity, and drug therapy: a prospective study of effects on 2205 pregnancies. Obstet Gynecol. 2003;102(4):739-52.
28. Liu S, Wen SW, Demissie K, Marcoux S, Kramer MS. Maternal asthma and pregnancy outcomes: a retrospective cohort study. Am J Obstet Gynecol. 2001;184(2):90-6.

About the authors

Maria Luiza Doria Almeida
Adjunct Professor. Federal University of Sergipe, Aracaju, Brazil.

Priscila Andrade Santana
Physician. Federal University of Sergipe, Aracaju, Brazil.

Alzira Maria d'Ávila Nery Guimarães
Adjunct Professor. Nursing Department, Federal University of Sergipe, Aracaju, Brazil.

Ricardo Queiroz Gurgel
Adjunct Professor. Department of Medicine, Federal University of Sergipe, Aracaju, Brazil.

Elcio Oliveira Vianna
Associate Professor. University of São Paulo at Ribeirão Preto School of Medicine, Ribeirão Preto, Brazil.